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The Effect of Weight Training on Explosive Power and Leg Strength During a Basketball Season

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THE EFFECT OF WEIGHT TRAINING ON EXPLOSIVE POWER AND LEG STRENGTH DURING A BASKETBALL SEASON

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser Date

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TABLE OF CONTENTS

Chapter		Page
I	Introduction	1
II	Review of Related Studies	3
III	Procedure for Obtaining Data	10
IV	Analysis of Data	16
V	Summary	19
	References Cited	22
	Appendix A: Description and Administration of Explosive Power Test	25
	Appendix B: Example of Increasing Weight for the Heel Raise	27
	Appendix C: Raw Scores for Tests	28

TABLE OF TABLES

Table | Page

I Initial and Final Means, Mean Gains or Losses, Critical Ratios, and Levels of Confidence for Group W and Group C 18

TABLE OF FIGURES

Figure Page

1 Explosive Power Testing Apparatus 11

Chapter I

INTRODUCTION

Reasons for Study

Athletic coaches and athletes have shown considerable interest in weight training as a means of increasing explosive power and leg strength. It is thought that this interest has been due mainly to studies which have indicated a positive relationship between weight training and jumping. It appears that many basketball coaches use weight training in pre-season conditioning but discontinue its use when the regular season begins.

O'Connor and Sills[1], after conducting a pre-season weight-training program, stated that there should be no reason why weight training could not be performed during the season and particularly for those boys who appeared to be improving their vertical jump at that time.

[1]Frank O'Connor and Frank Sills, "Heavy Resistance Exercises for Basketball Players," Athletic Journal, June, 1956, p. 6.

As the basketball season progresses it is important that the players maintain leg strength and explosive power. Therefore, the attempt was made in this study to determine whether a prescribed weight-training program will increase leg strength and explosive power during a basketball season.

Statement of Problem

This study was conducted with the purpose of determining what changes, if any, took place in leg strength and explosive power as a result of a systematic weight-training program during a basketball season.

Limitations of Study

The length of the weight training period was limited to four weeks due to a prolonged vacation period during the basketball season. Originally 16 subjects were to have participated in the study however this number was reduced to 10 due to scholastic difficulties and injuries.

Chapter II

REVIEW OF RELATED STUDIES

Report of Pertinent Findings

The role of weight training as a preparation for athletic competition is a relatively new innovation. There have been studies conducted on weight training and its relation to speed, strength, co-ordination, speed of muscular contraction, and as a means of therapeutic treatment. The apparent positive results of these studies have led coaches and athletes to incorporate weight training into their training programs.

Zorbas and Karpovich[2] studied the effect of weight training on the speed of contraction of muscles of the arm and shoulder girdle. Six-hundred men, whose ages ranged from 18 to 30, were used as subjects. They were divided into two groups of 300 each. One group was comprised of weight-lifters, who had participated in weight training for a minimum of six months. The other group had no experience in weight training and all the subjects were college students. Results indicated that weight-lifters had faster rotary arm motion than the non-lifters.

[2]William S. Zorbas and Peter Karpovich, "The Effect of Weight Lifting Upon the Speed of Muscular Contractions," Research Quarterly, May, 1951, pp. 145-148.

Masley, Harrabedian, and Donaldson[3] concluded that a six-week

[3]John Masley, A. Harrabedian, and D. Donaldson, "Weight Training in Relation to Strength, Speed, and Co-ordination," Research Quarterly, October, 1953, pp. 308-315.

period of weight training, where heavy resistance weights were used, increased strength, speed, and muscular co-ordination.

DeLorme[4] used heavy resistive exercises as a means of thera-

[4]Thomas L. DeLorme, Progressive Resistive Exercises, p. 37.

peutic treatment. He applied heavy resistive exercises to subjects whose muscles were weakened or atrophied as a result of injury or disease. DeLorme concludes:

> Low repetition, high resistive exercises produce power. In order to obtain rapid hypertrophy in weakened, atrophied muscles, the muscles should be subjected to strenuous exercising at regular intervals, to the point of maximum exertion.[5]

[5]Ibid., p. 48.

Chui[6] conducted a study relative to the effects of a system-

[6]Edward Chui, "The Effect of Systematic Weight Training on Athletic Power," Research Quarterly, October, 1950, pp. 188-195.

atic weight-training program on the Sargent Jump (standing and running), standing broad jump, eight-and twelve-pound shot put from a standing position, and the 60-yard dash. The weight-training group consisted of 23 subjects, and 22 subjects from a required physical education class

were utilized as the control group. Both groups met twice each week for forty minutes. The study extended over a period of three months. Although no scores were computed to determine the level of confidence, the results as related to jumping indicated that the weight-training group had significant gains in areas tested, whereas the control group showed no significant gains.

One of the first studies to use weight training in connection with basketball was conducted by O'Connor and Sills[7]. They studied the

[7]O'Connor, op. cit., p. 5.

effect of a weight-training program on jumping performance of varsity basketball players at the State University of Iowa. The program was six weeks in length with weight training periods being scheduled three times per week. This program was conducted prior to the beginning of the basketball season. The following exercises were given: (1) finger and wrist curls, (2) forearm curls, (3) overhead extension, (4) forward raise, (5) heel raise, and (6) walking squat. The mean gain in vertical jump per player was almost 3 inches.

Brown and Riley[8] studied the effect of the heel raise exer-

[8]Robert J. Brown and Douglas R. Riley, "The Effect of Weight Training on Leg Strength and the Vertical Jump," (M.S. Thesis, Springfield College, 1957), pp. 23-26, 55.

cise on vertical jump and leg strength. They used 40 basketball candidates from the freshmen basketball squad at Springfield College as subjects. The study was conducted over a five-week period during the

pre-season conditioning program. The subjects were divided into groups, a weight-training group and a control group. The weight-training group performed a heel raise exercise three times per week. The Sargent Jump of the weight-training group showed a mean increase of 2.9 inches which was statistically significant. The control group showed a mean increase of .6 inches which was not statistically significant. The leg strength of the weight-training group showed an increase of 161 pounds as measured by the back and leg dynamometer, while the control group had a decrease of 70.4 pounds. The increase of 161 pounds was statistically significant.

Ness and Sharos[9] studied the effect of a weight-training

[9]Phillip E. Ness and Charles L. Sharos, "The Effect of Weight Training on Leg Strength and Vertical Jump," (M.S. Thesis, Springfield College, 1956), pp. 21, 45.

program on the vertical jump and leg strength. They used 30 varsity basketball candidates as subjects from Springfield College. These subjects were equated into two groups on the basis of Sargent Jump scores. Group A consisted of 15 subjects who were subjected to a weight-training program. Group B consisted of 15 subjects who did no formal conditioning. The training period was four weeks in length prior to the basketball season. Group A met three days a week and performed two exercises: (1) deep knee bends and (2) the heel raise. The Sargent Jump of the exercising group showed a mean increase of 3.23 inches, while the control group had a mean decrease of .27 inches. The increase of Group A was statistically significant at the .01 level of confidence.

In leg strength, the exercising group had an increase of 215.46 pounds as compared to 25.34 pounds mean gain by the control group using the back and leg dynamometer as the measuring instrument. The gain by Group A was significant at the .01 level, while the gain by the control group was insignificant.

Darling[10] studied the effect of two exercises, the heel raise

[10]Donald E. Darling, "A Comparative Study to Determine the Effect of Heel Raise and Deep Knee Bend Exercises on the Vertical Jump," (M.S. Thesis, Springfield College, 1960), pp. 24-25, 39.

and deep knee bends, on the vertical jump of high school basketball players. He used 20 high school junior varsity basketball players as subjects. They were equated into two groups with Group A participating in the heel raise exercise and Group B participating in the deep knee bend exercise. The groups performed these exercises three times per week for five weeks. He concluded that a weight-training program for a period of five weeks involving both the heel raise and the deep knee bend exercises will significantly increase vertical jumping ability.

Garth[11] conducted a study using a systematic weight-training

[11]Richard L. Garth, "A Study of the Effect of Weight Training on the Jumping Ability of Basketball Players," (M.S. Thesis, State University of Iowa, 1954), pp. 11-12.

program with the purpose of developing all parts of the body. It was his contention that the upper body is as important in jumping ability as are the legs. He used 19 varsity basketball players at the State University of Iowa as subjects. The weight-training program was six

weeks in length prior to the basketball season. The following exercises were used with heavy resistive weights: press, curl, forward raise, sideward raise, walking squats, and jumps. The sole test for evaluation was the Sargent Jump on which they were allowed to take one step before jumping. The results showed a 2.76 and 2.71 inch increase on the means of the heights jumped when reaching with the right and left hand, respectively.

All of the previously cited studies of weight training as related to vertical jump and leg strength were conducted as part of the pre-season conditioning programs. However, Wickstrom[12] theorized

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[12]R. L. Wickstrom, "Post Season Weight Training for Basketball Players," Athletic Journal, April, 1959, pp. 38-40, 69-70.

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that jumping ability was stabilized by the latter part of the basketball season. Therefore, the players would not increase their vertical jump at this time. Three days after the season had ended, 13 Wichita University varsity basketball players took part in a weight-training program for six weeks, three times weekly. The exercises performed were: (1) alternate (dumbbell) press, (2) alternate (dumbbell) curl, (3) sit-up with weight, (4) one-half squats, (5) bent-over rowing, (6) squat jump with weight, and (7) ordinary dead lift. The mean increase was 1.5 inches in jumping height as measured by the standard jump and reach test.

Many coaches feel that a season of constant jumping and bounding by basketball players will decrease their jumping ability.

Jacobsen[13] attempted to determine the effect that a basketball season had on the leg strength and vertical jump of basketball players. He used 17 varsity and freshmen basketball players at South Dakota State College as subjects. They were tested for explosive power and leg strength at the beginning, twice during the season, and at the end of the basketball season. He concluded that the gain in leg strength between all tests was significant. There was not a significant increase in explosive power, but there was a slight over-all decrease in the Sargent Jump.

[13]Donald D. Jacobsen, "The Effects of a Basketball Season on Leg Strength and Explosive Power as Shown on a Select Group of Players at South Dakota State College," (M.S. Thesis, South Dakota State College of Agriculture and Mechanic Arts, 1962), p. 25.

Summary

There have been many different exercises involved in the various studies that have been conducted on weight training in basketball. However, the findings of most studies indicate that where a program of systematic weight training has been employed, an increase in leg strength and vertical jump has resulted.

Chapter III

PROCEDURE FOR OBTAINING DATA

Introduction

The instruments used for obtaining data, the subjects used in the experiment, and the training program are described in this chapter.

Eleven members of the freshmen basketball team at South Dakota State University were used as subjects for the experiment. The number was later reduced to 10 as a result of an injury sustained to one subject in a game. The length of the study was five weeks with two days used for taking the initial measurements and two days for the final measurements.

Measurements

Explosive Power

The explosive power performance was measured with an apparatus (see Figure 1) similar to the vertical-jump apparatus used by Henry[14] and which has been described by Pacheco[15]. The test for

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[14] Franklin Henry, "The Practice and Fatigue Effects in the Sargent Jump," Research Quarterly, May, 1942, pp. 18-19.

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[15] Betty A. Pacheco, "Improvement in Jumping Performance Due to Preliminary Exercise," Research Quarterly, March, 1957, pp. 57-58.

Figure 1. Explosive Power Testing Apparatus

explosive power was administered immediately before and at the end of the four-week training program. A description of the vertical-jump apparatus used in this study is found in Appendix A.

Leg Strength

The test was administered as follows: (1) The headpiece was strapped to the subject's head. (2) The subject was then instructed to stand at attention with his hands at his sides. (3) The subject was positioned directly under the first pulley, a position marked by a cross painted on the floor. (4) A mark was made on the paper by the tester at the point of contact of the pen to the paper to determine the starting point of the jump. (5) The subject then placed his thumbs in his waistband, crouched, and jumped upward. The subject was limited to a dip of approximately 12 inches from the standing position. When it was apparent that the jumper did not jump straight upward, this fact was brought to the jumper's attention. (6) This procedure was repeated three times or if the subject felt that he could jump higher he was allowed additional jumps. The best jump was recorded.

A Cable-Tension Strength Test, originated by H. Harrison Clarke[16], was employed to measure leg strength. An aircraft tensiome-

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[16]H. Harrison Clarke, Cable-Tension Strength Tests, p. 29.

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ter was used in recording the muscular strength. The measurements were taken for both the right and left leg, and the scores were added to

give one score for leg strength. The subjects were tested at the beginning and at the end of the training period.

In administering the leg strength test the subject was seated at the end of the testing table in a backward-leaning rest position with arms extended to the rear and hands grasping the sides of the testing table. A regulation strap was secured around the lower leg midway between the knee and the ankle joint. A folded towel was placed under the knee joint to cushion it as the test was in progress. When the pulling assembly was taut, the lower leg was extended to an angle of 115 degrees (measured by a goniometer through the center of the knee joint and the upper and lower leg). The tensiometer was then secured on the cable by the author and with the command "push," the subject extended his lower leg maximally. This test was repeated three times and the highest of the three readings was recorded as the subject's strength score of lower leg extension.

Training Program

The subjects were equated into two groups, a weight-training group and a control group, using the scores obtained on the initial explosive power test. The subjects were placed in their respective groups so that the mean jump of both groups was equal. Hereafter, the weight-training group will be referred to as Group W and the control group will be designated as Group C.

The training program was four weeks in length, ending one week after the end of the basketball season.

Group W participated in a weight-training program using barbells three days a week for four weeks. They performed the two exercises, the heel raise and the one-quarter walking squat.

The heel raise was performed on a two-inch board with barbells across the shoulders. The subject performed two sets of ten repetitions and as many as possible on the third set with a one-minute rest between sets. The subject placed the balls of his feet on the board and performed the exercise by rising as high as possible on his toes. The initial weight to be lifted was determined by taking one-third of the individual's body weight. Five pounds were added each training day plus one pound for every repetition over ten on the third set. If the subject failed to complete the required 10 repetitions on the third set, the five pounds were not added and the weight remained the same (see appendix for illustration).

The one-quarter walking squat was performed with the barbell resting across the shoulders. The subject performed two sets of ten repetitions and as many as possible on the third set with a one minute rest between each set. The initial weight to be lifted was determined by taking one-half the body weight of the subject. The same method of adding weight was used as in the heel raise.

The subject performed the one-quarter walking squat by placing one foot approximately in front of the other foot and dipping one-quarter of the way down and then stepping forward one step and continuing this for five steps. He then completed the cycle stepping backwards five steps. This constituted one set of ten repetitions.

As a safety factor the barbell was padded with sponge rubber and the barbell was placed in a weight rack approximately five feet high for ease of handling. The exercises were spotted by two other members of the group.

Two sets of barbells were used with each subject performing the heel raise first and then doing the one-quarter walking squat.

Both groups took part in the regular basketball practice.

Chapter IV

ANALYSIS OF DATA

Introduction

The primary purpose of this investigation was to determine the effect of a systematic weight-training program on the explosive power and leg strength of 10 freshmen basketball players at South Dakota State University during the 1964-65 basketball season.

Scoring of Data

The raw scores obtained on the explosive power test were recorded in centimeters and required no conversion. The raw scores (tension pounds) obtained in the leg strength test were converted to pounds.

Reliability of Data

The reliability of the explosive power test was determined through a test-retest method. A rho or rank order correlation was computed and a reliability quotient of .86 was obtained. The objectivity coefficient for the leg strength test was .94.

Analysis of Data

The analysis of data for this investigation dealt with the mean gain or loss difference between the experimental group and the control group in both tests. The author employed the statistical

method suggested by McCloy[17] to determine the critical ratio

[17]Charles McCloy and Norma Young, Test and Measurements in Health and Physical Education, p. 430.

(t ratio). The null hypothesis was rejected if the critical ratio obtained was greater than 2.31. The one percent level of confidence was chosen and eight degrees of freedom were present in this investigation. The same method was used in the explosive power and the leg strength analysis.

Explosive Power Test

The mean gain of Group W (experimental group) was 2.8 centimeters. A mean loss of 1.9 centimeters was recorded by Group C (control group). The critical ratio of the difference between the experimental group and the control group was found to be 2.92 and this was not significant at the one percent level of confidence. The null hypothesis was accepted.

Leg Strength Test

Both the experimental and the control group showed a mean loss in leg strength. The experimental group showed a mean loss of 37.28 pounds and the control group a mean loss of 19 pounds. The critical ratio of .62 of this difference was not significant at the one percent level of confidence and the null hypothesis was accepted.

Summary of Findings

The subjects in the weight-training group showed a mean increase in explosive power while the control group showed a decrease (Table I). The difference between the mean increase of Group W and the mean decrease of Group C was not significant at the one percent level of confidence. Both groups decreased in leg strength but the decrease was not statistically significant.

Table I

Initial and Final Means, Mean Gains or Losses, Critical Ratios, and Levels of Confidence for Group W and Group C

	Initial Mean	Final Mean	Mean Gain or Loss	C.R.	Levels of Confidence
Explosive Power (centimeters)					
Group W	44.5	47.6	+ 2.8	2.92	.02
Group C	46.6	44.7	- 1.9		
Leg Strength (pounds)					
Group W	502.2	464.9	-37.3	.62	.55
Group C	443	424	-19		

Chapter V

SUMMARY

Problem

The primary purpose of this investigation was to determine the effect of a systematic weight-training program on the explosive power and leg strength of 10 freshmen basketball players at South Dakota State University during the 1964-65 basketball season.

Data

The subjects in this study were freshmen basketball players at South Dakota State University during the 1964-65 basketball season. The subjects participated in a four-week training program consisting of training sessions conducted three times a week. Each session was made up of two weight-training exercises: heel-raising and one-quarter walking squats. Three exercise intervals, 10 repetitions for the first two intervals and as many as possible on the third interval, were performed in each session.

Two tests, explosive power and leg strength, were administered at the beginning and at the end of the four-week training program.

The data were recorded in centimeters for the explosive power test and pounds for the leg strength test. The recordings were statistically treated to determine the effect the systematic weight-training program had upon explosive power and leg strength during the 1964-65 basketball season.

Findings

In the explosive power test the mean of the scores of the experimental group increased, whereas the mean of the control group decreased. The difference between the mean increase of the experimental group and the mean decrease of the control group was not statistically significant at the one percent level of confidence.

In the leg strength test both Group W (experimental) and Group C (control) decreased in leg strength and the difference between the losses was not significant.

Conclusions

The findings of this study appear to indicate that a systematic weight-training program will not significantly increase explosive power during a basketball season. The results of the leg strength test appear to indicate that a season of bounding and jumping might contribute to decreased leg strength in basketball players since the training program did not increase leg strength in the experimental group.

Recommendations for Further Study

Based on the experiences of the author in this study, the following recommendations are made:

1. That this study be repeated using a longer training program involving the entire basketball season.

2. That a larger sample be employed in further studies.

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APPENDIXES

APPENDIX A

DESCRIPTION AND ADMINISTRATION OF EXPLOSIVE POWER TEST

Description of Measuring Instrument

The headpiece was so constructed so that it could be adjusted horizontally to fit the subject's head and also vertically so it could be fastened underneath the subject's chin. A non-stretching braided nylon cord was attached to the top of the headpiece and extended upward over a 1 1/2 inch pulley mounted 9 feet 3 inches above the floor. From this pulley the cord passed horizontally 3 feet over a second pulley mounted 3 inches from the wall. From the second pulley the cord passed downward to a third pulley which permitted the cord to pass 4 feet horizontally to an automatic take-up reel. The automatic take-up reel placed the cord under tension. On the wall in front of the cord, which ran from the take-up reel to the third pulley, a rod 4 feet long and 1/2 inch thick was placed which carried one heavy-weight movable slider positioned 2 inches from the wall. The slider was attached to the cord and moved back and forth with the subject's jump. Attached to the wall was a spool of wrapping paper 36 inches wide which in turn was fastened to two metal rods 6 1/2 inches apart. This scroll-like affair could be rolled up or down for testing a new individual. A water color pen with a felt tip was fastened on the slider and the felt tip moved with the slider making a mark on the paper. The subject's standing height was determined when, preliminary to the jump, the subject was standing erect and a mark was made on the paper at the point

the pen was at that time. When the subject jumped, a line was drawn by the pen the entire length of the subject's jump. After the jump the height the subject had jumped was determined by measuring the distance between the standing height and the farthermost point of the line made by the pen.

APPENDIX B

EXAMPLE OF INCREASING WEIGHT FOR HEEL RAISE

Monday — The weight of subject A is 180 pounds
1/3 X 180 pounds = 60 pounds
Subject A exercises with 60 pounds
On the third set of exercises Subject A performs 30 repetitions.

Wednesday — Subject A exercises with 85 pounds

Monday	60 pounds
Increase of weight each training day	5 pounds
Repetitions over 10 on the last set = 20 (1 pound for each repetition over 10)	20 pounds
Weight to be used on Wednesday	85 pounds

NOTE: This rule would apply to subjects performing the one-quarter walking squat with the exception the initial weight to be lifted would be one-half of the subject's body weight instead of one-third of the subject's body weight as in the heel raise exercise.

APPENDIX C

RAW SCORES FOR EXPLOSIVE POWER (CENTIMETERS) AND LEG STRENGTH (POUNDS) TESTS

	Explosive Power		Leg Strength	
	Initial	Final	Initial	Final
Group W				
Subject Number				
1	43	45	560	520
2	47.5	51	436	480
3	40	46.5	595	540
4	45.5	48.5	530	445
5	48	47	390	339.6
Group C				
Subject Number				
6	49	46	356.6	340
7	54	56	505.3	420
8	38	34	433	408
9	42	39	333.4	327
10	50	48.5	586.7	625